Does economic recession adversely affect mortality from heart disease? This study indicates that it does and that economic upturns are associated with decreased heart disease mortality. Some possible reasons are discussed.

ECONOMIC CHANGES AND HEART DISEASE MORTALITY

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Introduction

MUCH speculation and an increasing amount of empirical research has been devoted to the issue of psychophysiological factors in the incidence of, and mortality from, heart disease.[1-6] Among the major social stresses that may be involved in heart disease incidence or mortality are those which originate in adverse changes in the economic status of individuals. Adverse changes in economic status would restrict the degree to which individuals would be able to procure a great proportion of the goods and services valued in the society—from the most basic—such as food, clothing, and shelter—to the more lofty, including participation in the cultural, intellectual, and artistic life of the society.

The economic status of individuals is to a large extent dependent on the economic standing, growth rate, and economic stability of the society as a whole. Periods of instability, particularly periods of economic recession, force a sizable portion of the population either out of the economy, as in unemployment, or into a situation of decreased income. In either case, the effect of an economic downturn is to substantially reduce the ability of segments of the population to procure fundamental, as well as highly valued, products and services of the society. We may therefore hypothesize that the various types of stress inherent in an economic downturn might lead to an increase in heart disease mortality.

It is also a reasonable speculation that heart disease mortality might increase during an economic downturn as a result of the decreased availability, in economic terms, of medical care services. Thus, it is possible that, in reduced financial circumstances, some individuals would be less inclined to utilize medical and hospital services even in the event of rather painful and incapacitating symptoms which result in death. A larger hypothesis of the present study, therefore, suggests that either, or both, psychophysiological stress and decreased financial resources for medical care would increase the rate of heart disease mortality during an economic downturn.

Data

The present study investigated the relationship between economic change and heart disease mortality in New York State[7] and the United States[8] over the period 1900-1967. The measure of economic change in New York State was the employment index for nonagricultural industries which was available for the period 1915-1967.[9] Several economic studies, in addition to this one, have shown that fluctuations in the manufacturing employment index are closely re-

Figure 1—Fourier analysis of the relationship between the New York State Employment Index for Nonagricultural Industries and the Inverted United States Unemployment Index, 1915-1962; sixth order Fourier representation of annual changes (first differences), average of 4- to 5-year changes[15]

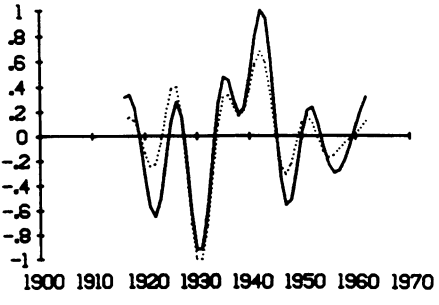
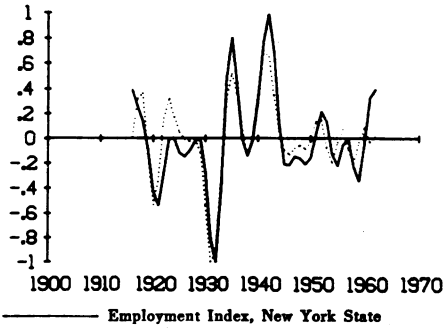


Figure 2—Fourier analysis of the relationship between the New York State Employment Index for Nonagricultural Industries and the Inverted United States Unemployment Index, 1915-1962; twelfth order Fourier representation of annual changes (first differences), average of 2- to 3-year changes[15]

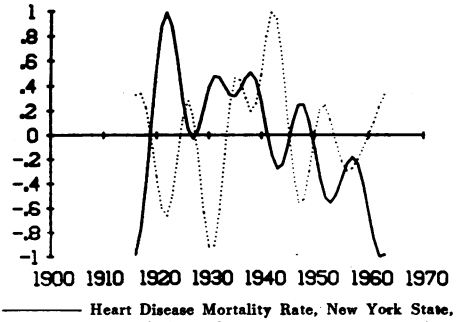


lated to, and highly indicative of, fluctuations in several major national economic indicators, including gross national product, industrial production, personal income, and annual wages earned and hours worked.[10,11] For the United States as a whole, the indicator of economic change used is based on an estimate of unemployment for the United States since 1900,[12] which is unfortunately not available for New York State until 1929. In order to make the United States unemployment index consistent with other major but positive economic indicators, the inverted unemployment index was used; namely, 100.00 minus the percentage of persons unemployed. Figures 1 and 2 show the highly precise positive relationship, over time, between fluctuations in the manufacturing employment index, New York State, and the inverted unemployment index for the United States. Figure 1 shows this relationship in terms of 8- to 10-year cycles (or 4- to 5-year changes) while Figure 5 represents the relationship within smaller, 4- to 5-year cycles (or 2- to 3-year changes).

Analysis

Figure 3 shows the inverse relationship between fluctuations in the New York State employment index and changes in the rate of total heart disease mortality in New York State, 1915-1967. Four different techniques were used to measure the inverse relationship between eco-

Figure 3—Fourier analysis of the relationship between the New York State Employment Index for Nonagricultural Industries and the heart disease mortality rate, New York State, 1915-1967; sixth order Fourier representation of annual changes (first differences), average of 4- to 5-year changes[15]



nomic change and heart disease mortality. These methods included: (1) matching the economic and heart disease mortality data after long-term trends in employment and heart disease mortality were algebraically substracted; (2) matching the economic and heart disease mortality data in terms of 3- and 5-year changes; (3) the economic and heart disease mortality data were transformed into annual changes (or first differences, in statistical terms) and examined in terms of variously sized moving averages as determined by polynominal curve-fitting; and, finally, (4) after the earlier procedures indicated the general range of the correlations and the lag between economic change and heart disease mortality, Fourier analysis[13] was used to determine the spans of time for which the relationship, based on annual changes, was optimally predictable. Thus, for example, the first three statistical procedures determined that a relationship within the -0.80 to -0.90 range of Pearsonian correlation was to be found for the New York State heart disease mortality rate.[14]

Furthermore, it appears that patterns of change in heart disease mortality lag behind changes in employment by two years. The estimate of the interval of this lag is based on the observation that the inverse relationships were found to reach their optimum negative correlation when the mortality data are lagged by approximately two years. A peak in heart disease mortality, for example, will generally occur two years after a trough in the employment index.

The next procedure was to determine, by Fourier analysis, the optimal large and small time intervals for which the relationship could be reliably observed. In the case of total heart disease for New York State, the inverse relationship is reliable for cycles as long as 8 to 10 years, or intervals of 4 to 5 years, and as short as 4- to 5-year cycles, or 2- to 3-year intervals. Figure 3, for example, shows the relationship between economic change and heart disease mortality in New York State for an interval of 4 to 5 years (represented by a sixth order Fourier curve of approximately 8- to 10-year cycles), with heart disease mortality lagging two years behind the employment index. The Pearsonian correlation coefficient for this relationship is -0.834, controlling for the effects of autocorrelated residuals.[14] Relationships very similar to the one shown in Figure 3 were found for total heart disease mortality in New York City, and for New York State except for New York City. Figure 4, for example, shows the inverse relationship, represented by a 13th order Fourier curve, between heart disease mortality in New York State, except for New York City, as against the New York State employment index. As distinguished from Figure 3 which showed the relationship in terms of an 8- to 10-year cycle, or 4- to 5-year interval, Figure 4 shows the relationship in terms of approximately a 3- to 5-year cycle or 2- to 3-year interval. Apart from the consistent cycle-for-cycle inverse relationship between the series, this relationship is slightly disturbed dur-

Figure 4—Fourier analysis of the relationship between the New York State Employment Index for Nonagricultural Industries and the heart disease mortality rate, New York State, 1915-1967; thirteenth order Fourier representation of annual changes (first differences), average of 2- to 3-year changes[15]

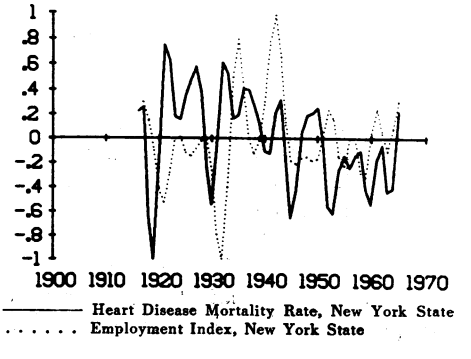
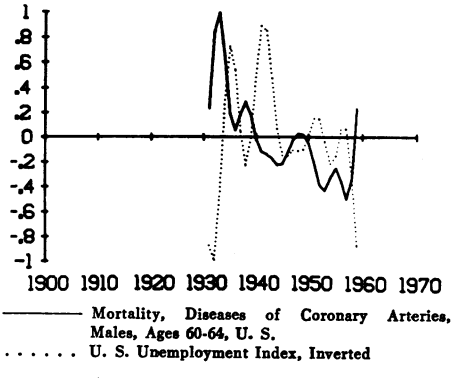


Figure 5—Fourier analysis of the relationship between the Inverted United States Unemployment Index and mortality of white males aged 60-64 from diseases of coronary arteries, United States, 1930-1960; sixth order Fourier representation of annual changes (first differences), average of 2- to 3-year changes[15]



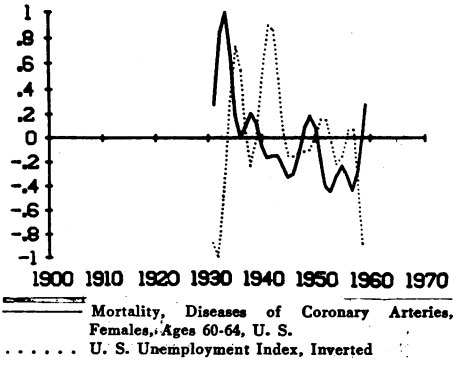
ing the Second World War period when heart disease mortality apparently increased.

For the United States as a whole, total heart disease mortality, cross-classified by age, sex, and race, was examined in relationship to the inverted unemployment index. In order to maximize the accuracy of observation of the inverse relationship, it was necessary to subdivide total heart disease mortality into major diagnostic classifications and then into age, sex, and racial subcategories. The major diagnostic subgroupings included rheumatic heart disease, arteriosclerotic heart disease, arteriosclerosis, and diseases of coronary arteries. Among these diagnostic classifications the inverse relationship between economic change and heart disease mortality was most consistent for age and sex classifications of coronary artery disease. Figure 5 shows the inverse relationship between 3- to 5-year cycles (or 2- to 3-year changes) in the inverted United States unemployment index and coronary artery disease mortality in the United States of 60- to 64-year-old white males, as represented by a sixth order Fourier curve. Once again we may note the slight disturbance in this relationship that occurred during the Second World War and that produced a minor increase in mortality despite increased economic prosperity. Nearly the identical picture (see, e.g., Figure 6) can be observed for all 5-year age groupings of whites between the ages of 35 and 95. For blacks, the relationship is somewhat less consistent among age and sex groupings, but is nevertheless strongly inverse.

Conclusion

The findings of the present study clearly indicate that economic downturns are associated with increased mortality from heart disease and that, conversely, heart disease mortality decreases during economic upturns. It is difficult, at this point in the study, to ascertain whether the factors linking economic change and heart disease mortality are entirely related to psychophysiologic stress, whether economic factors in the utilization of health services have even a minor im-

Figure 6—Fourier analysis of the relationship between the Inverted United States Unemployment Index and mortality of white females aged 60-64 from diseases of coronary arteries, United States, 1930-1960; sixth order Fourier representation of annual changes (first differences), average of 2- to 3-year changes[15]



pact, or whether the relationship has some other basis. The second possibility, in any case, would not explain the 68-year inverse relationship between economic changes and heart disease mortality, especially in the case of coronary artery disease; it is only in the last six or seven years that even moderately effective methods of treating coronary artery disease have been introduced.

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labor force then of employment; the difference between the two provides the estimates of unemployment. The figures for decennial census years are used as benchmarks with interpolations made for intercensal years from a variety of available sources.)

13. Fourier analysis is a technique frequently used in electrical engineering and geophysics to determine the components of a complex trend. It is the first time, to this writer's knowledge, that these procedures have been used in the analysis of mortality data. For general references the reader is directed to: Lighthill, M. J. An Introduction to Fourier Analysis and Generalized Functions. Cambridge University Press, 1959; Papoulis, A. The Fourier Integral and Its Applications. McGraw-Hill, 1962. General treatments of the application of techniques of spectral analysis to economic data are found in Fishman, G. S. Spectral Methods in Econometrics. Harvard University Press, 1969; Granger, C. W. J. Spectral Analysis of Economic Time Series. Princeton University Press, 1964; Tintner, G. Econometrics. Wiley, 1952, pp. 216-238. Examples of the use of several of the detrending procedures referred to are found in Brenner, M. H. Economic Change and Mental Hospitalization: New York State, 1910-1960. Social Psychiat. 2:180-188, 1967; and Brenner, M. H. Patterns of Psychiatric Hospitalization Among Different Socioeconomic Groups in Response to Economic Stress. J. Nerv. and Ment. Dis. 148:31-38, 1968.
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15. Fourier curves of specific orders have been fitted to first differences (annual changes) in the series to be correlated. Both series were then scaled for viewing, such that the greatest amplitude from the arithmetic mean of each series (which is set equal to zero) has been normalized to +1.0 if positive, or −1.0 if negative.

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